NEW AND IMPROVED CLIMATE PARAMETERS FROM AIRS/AMSU

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AIRS Science Team Meeting

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NEW AND IMPROVED CLIMATE PARAMETERS

Research contained in AIRS Science Team climate proposal

Relates to the 3 most important parameters in TOVS Pathfinder data set

MSU2R, MSU4

Precipitation Estimate

OLR, clear sky OLR

All described in Susskind et al., Bull. Amer. Meteor. Soc., **78**, 1449-1472, 1997

MSU2R, MSU4

Spencer and Christy MSU2R and MSU4 are used widely to indicate global and regional temperature trends

Spencer and Christy uses direct observations of MSU channel 2 and MSU channel 4

Computes what MSU2 and MSU4 would have been from AMSU A observations

TOVS Pathfinder computes MSU2 and MSU4 from T_s, $\varepsilon_{50.3}$, T(p), q(p)

TOVS MSU2R and MSU4 trends are similar to Spencer and Christy trends

Relates MSU2R, MSU4 trends to computed T(p), T_s trends

COMPUTATION OF MSU2R, MSU4

Spencer and Christy

$MSU2R = 2\,[(MSU2^{OBS}(21.6°) + MSU^{OBS}(32.7°)] - 1.5\,[(MSU2^{OBS}(44.1°) + MSU2^{OBS}(56.5°)]$

One value per scan line

$MSU4 = MSU4^{OBS}$

TOVS

Use same formulas as Spencer and Christy but with MSU^{COMP}

MSU^{COMP} is based on retrieved values for accepted retrievals, but for each retrieval

Uses monthly mean gridded T(p), $\varepsilon_{50.3}$,T(p), q(p) at mandatory levels

AIRS

Uses same formulas for MSU^{COMP} based on retrieved values for mid-troposphere good cases

Can use monthly mean values

If monthly mean values are used, need gridded monthly mean ocean T_s, $\varepsilon_{50.3}$, based on mid-troposphere test

MSU^{COMP} can be done in post-processing mode

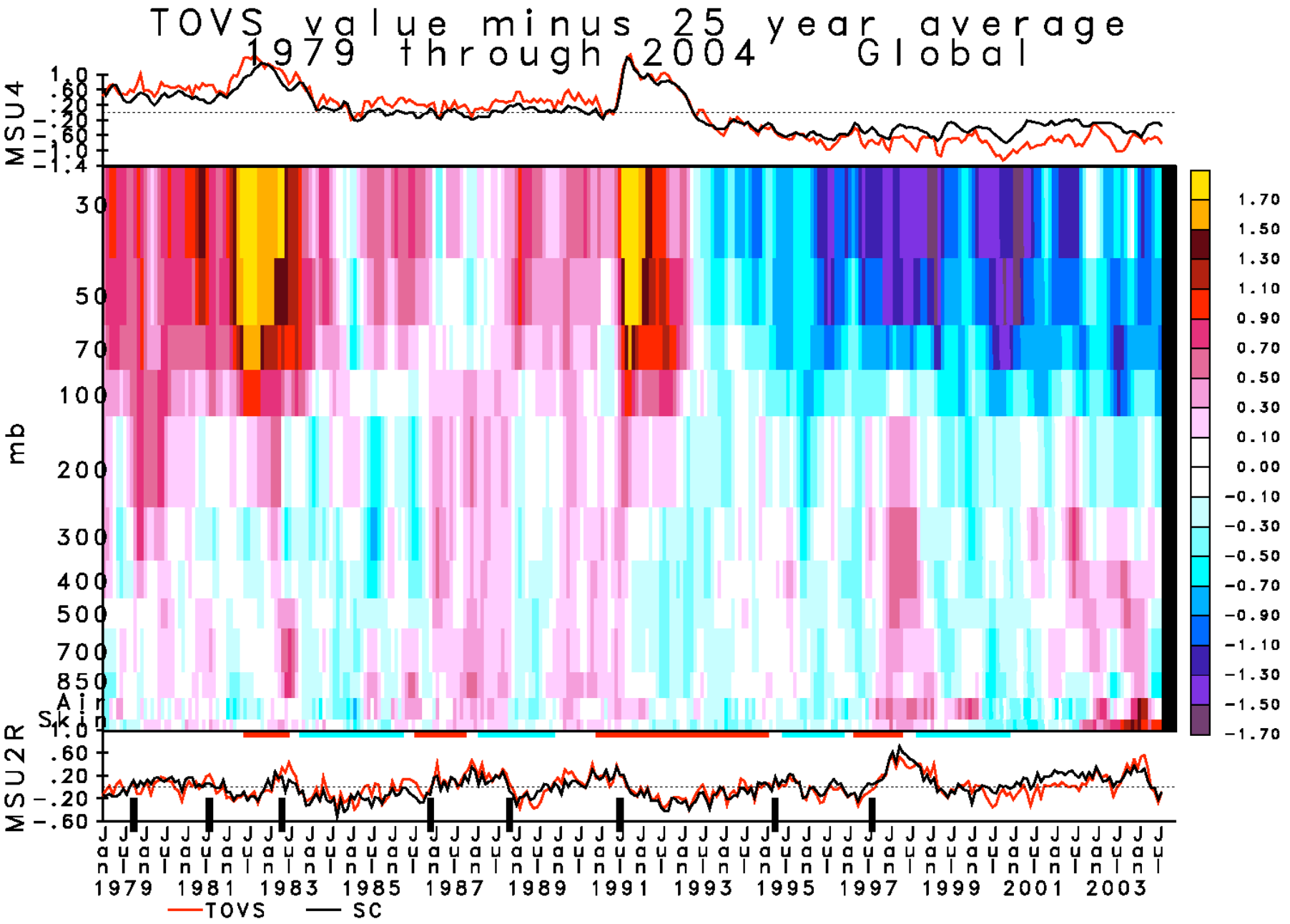
Better yet, do spot by spot MSU calculations for AIRS in level 2 code

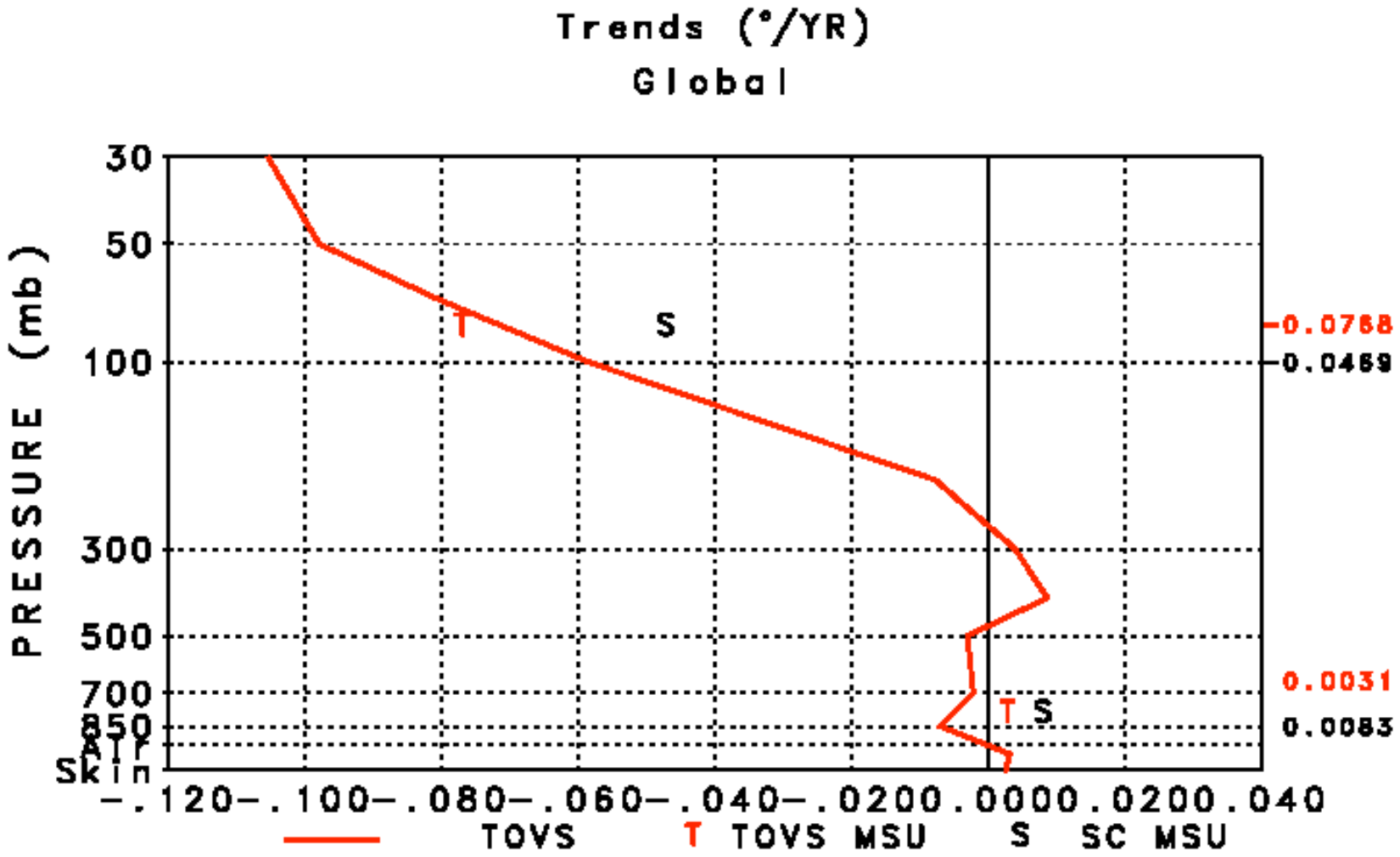
Use 100 level profile of T(p), q(p) for mid-troposphere good cases

Code is very quick

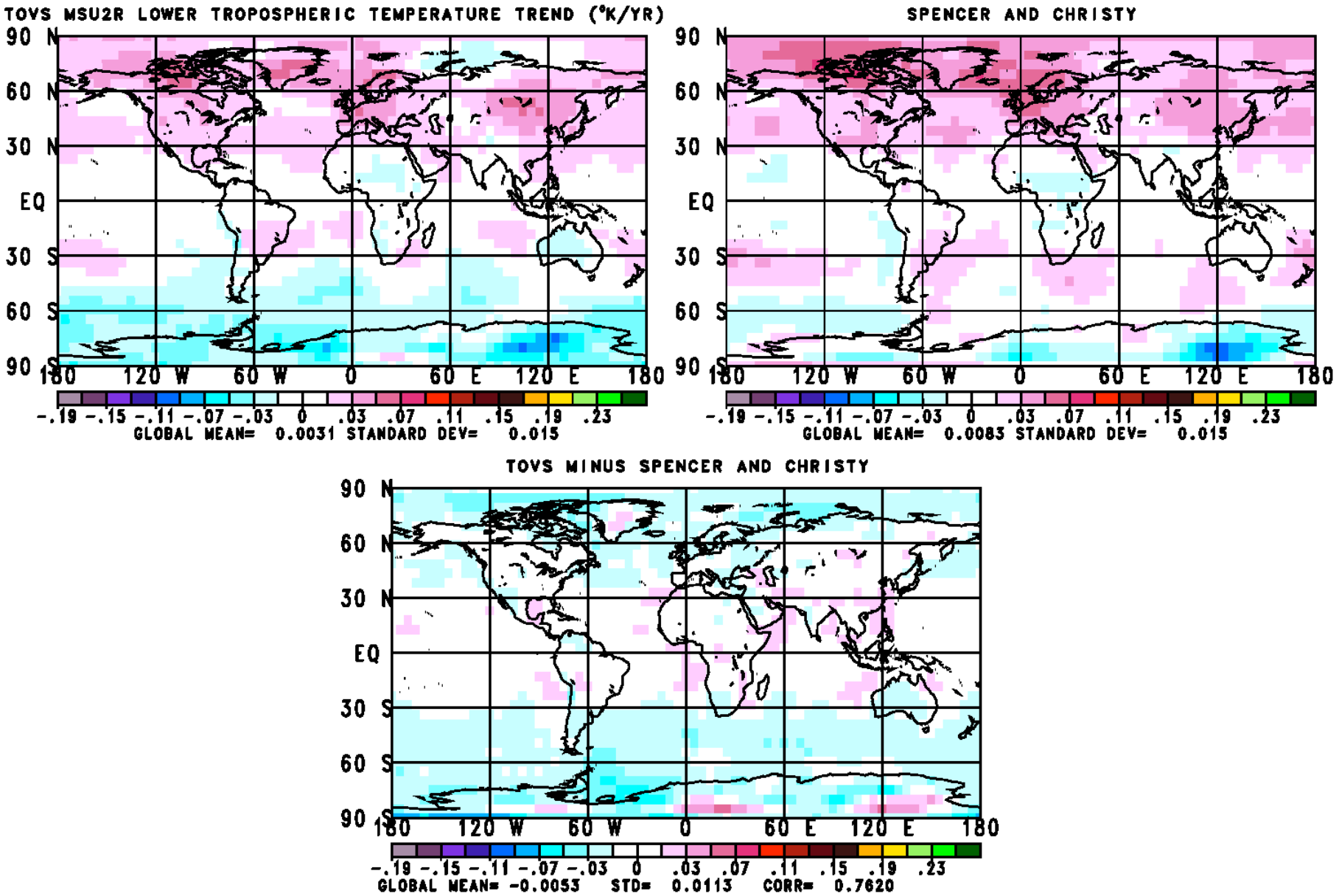
It is a subroutine call at the end of the final retrieval

Will not change any other result


TOVS value minus 25 year average
1979 through 2004 Global
MSU4
1.0
.60
.20
-.20
-.60
-1.0
-1.4
mb
30
50
70
100
200
300
400
500
700
850
Air
Skin
1.70
1.50
1.30
1.10
0.90
0.70
0.50
0.30
0.10
0.00
-0.10
-0.30
-0.50
-0.70
-0.90
-1.10
-1.30
-1.50
-1.70
MSU2R
1.0
.60
.20
-.20
-.60
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
TOVS
SC


Trends (°/YR)
Global
PRESSURE (mb)
30
50
100
300
500
700
850
ATM
Skin
T
S
T S
0.0768
0.0469
0.0031
0.0083
-.120 -.100 -.080 -.060 -.040 -.020 0.000 0.020 0.040
TOVS
T TOVS MSU
S SC MSU

MSU2R TEMPERATURE TREND (K/YR)
January 1979 through August 2004



PRECIPITATION ESTIMATE

TOVS Pathfinder

Empirically relates precipitation to $\alpha\varepsilon$, P_c, T(p), q(p)

Bob Adler uses TOVS precipitation estimate in official GPCP product

Best source of precipitation in polar regions

Huffman et al., J. Hydrometeor., **2**, 36-50, 2001 daily product

Adler et al., J. Hydrometeor., **4**, 1147-1167, 2003 monthly product

Bob Adler would like AIRS precipitation estimate as soon as possible (daily, monthly)

COMPUTATION OF PRECIPITATION ESTIMATE

TOVS

Computed on a sounding by sounding basis using $\alpha\varepsilon$, P_c, T(p), q(p)

Uses retrieved T(p), q(p) if retrieval is successful

Uses forecast T(p), q(p) if retrieval is rejected

Uses $\alpha\varepsilon, P_c$ determined from retrieval, or forecast if retrieval is rejected

AIRS

Computed on a sounding by sounding basis in level 2 code

Uses final product T(p), q(p), $\alpha\varepsilon$, P_c if IR/MW retrieval is produced

Uses microwave product T(p), q(p) and appropriate $\alpha\varepsilon$, P_c if IR/MW retrieval is not produced

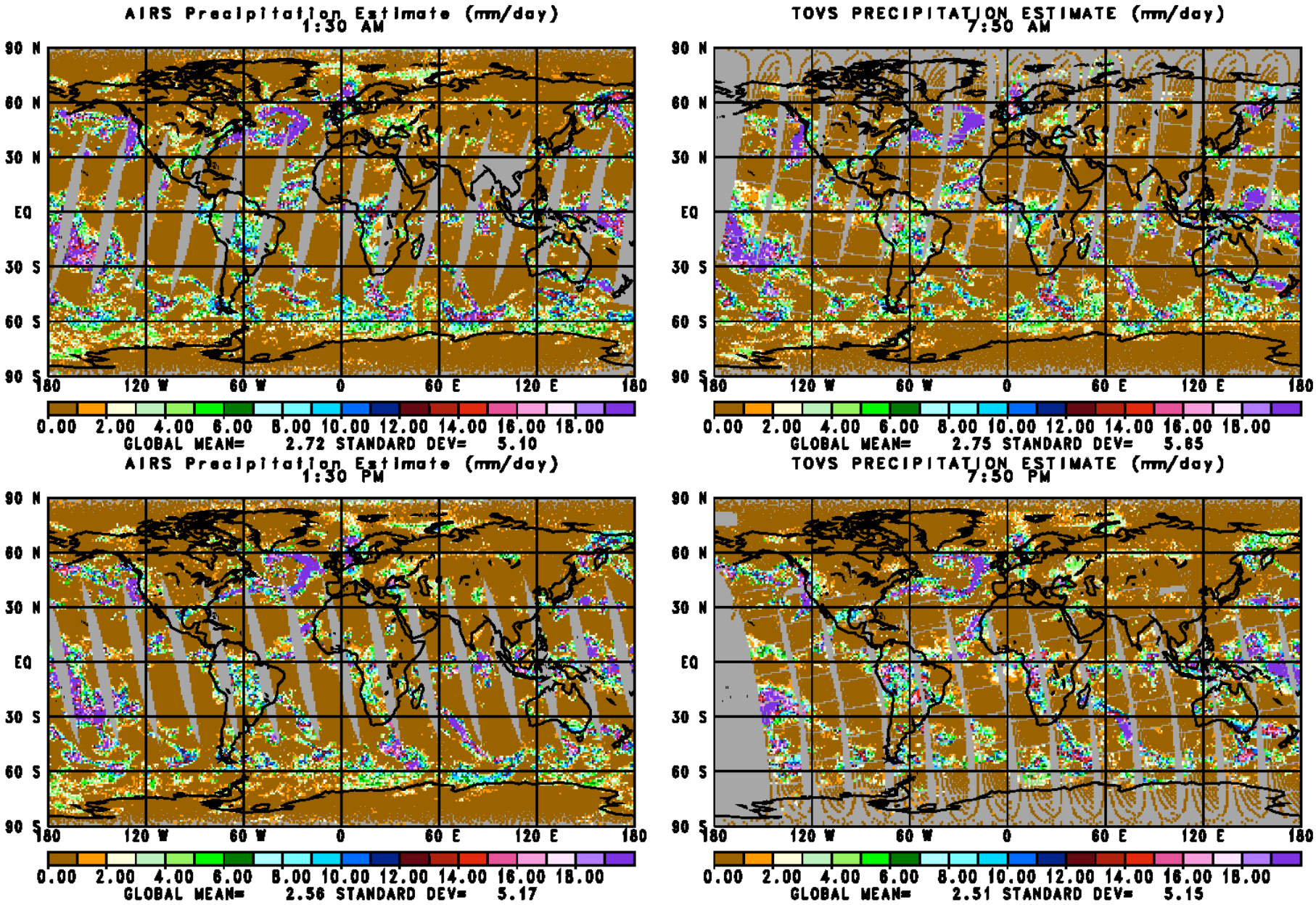
Subroutine is called as part of cloud retrieval subroutine

Calculation is very fast

Calculation does not change any other result

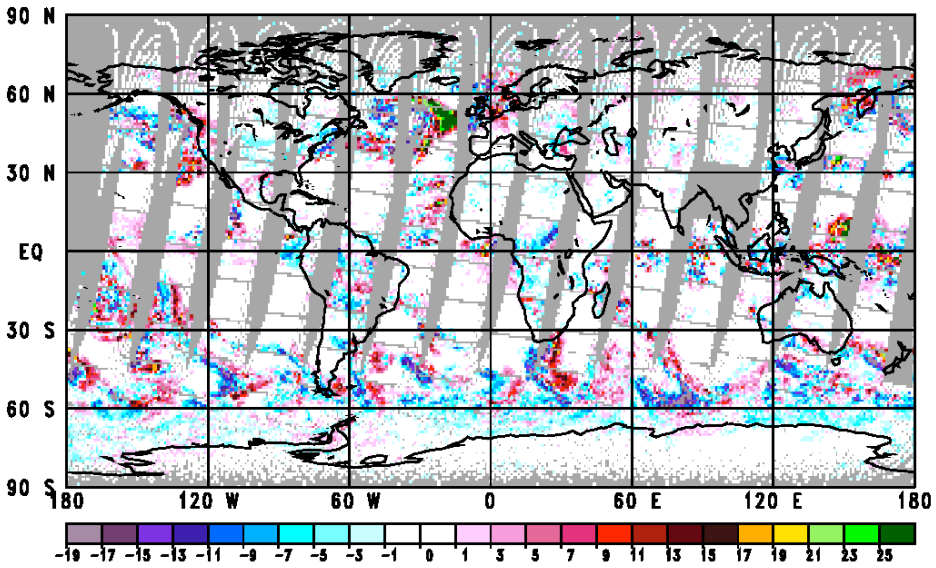
Ready to go now

PRECIPITATION ESTIMATE (mm/day)
January 6, 2004



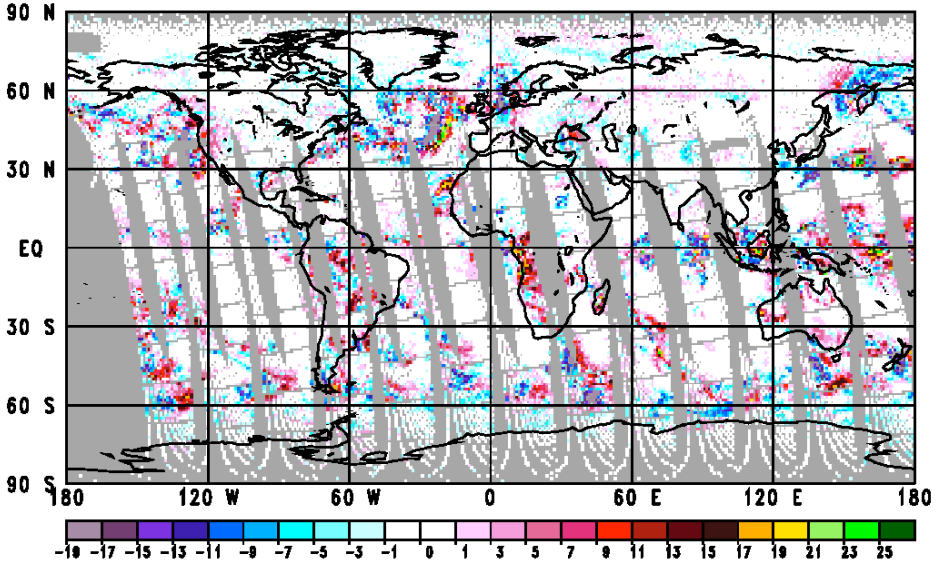
PRECIPITATION ESTIMATE (mm/day)
January 6, 2004

TOVS 7:50 AM minus AIRS 1:30 AM



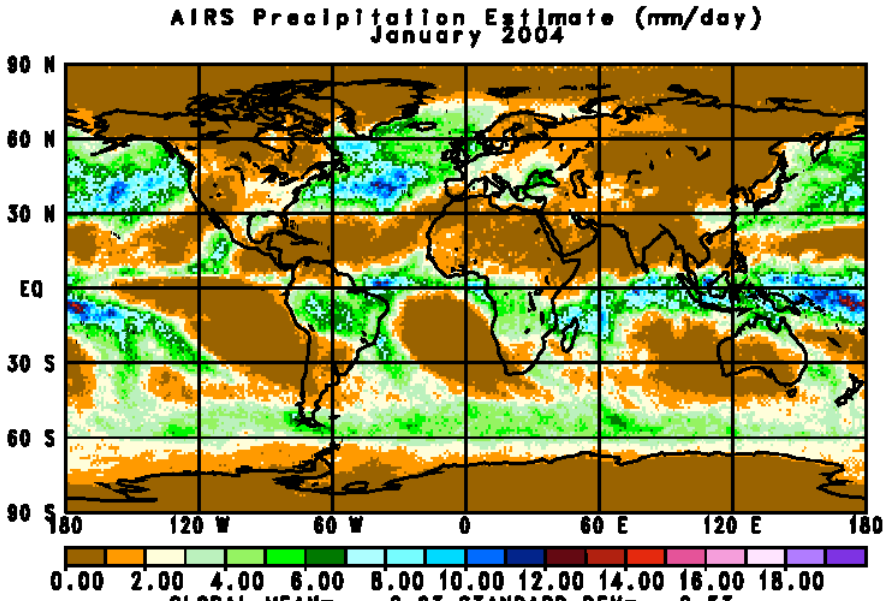
GLOBAL MEAN= -0.14 STANDARD DEV= 4.44 CORRELATION= 0.60

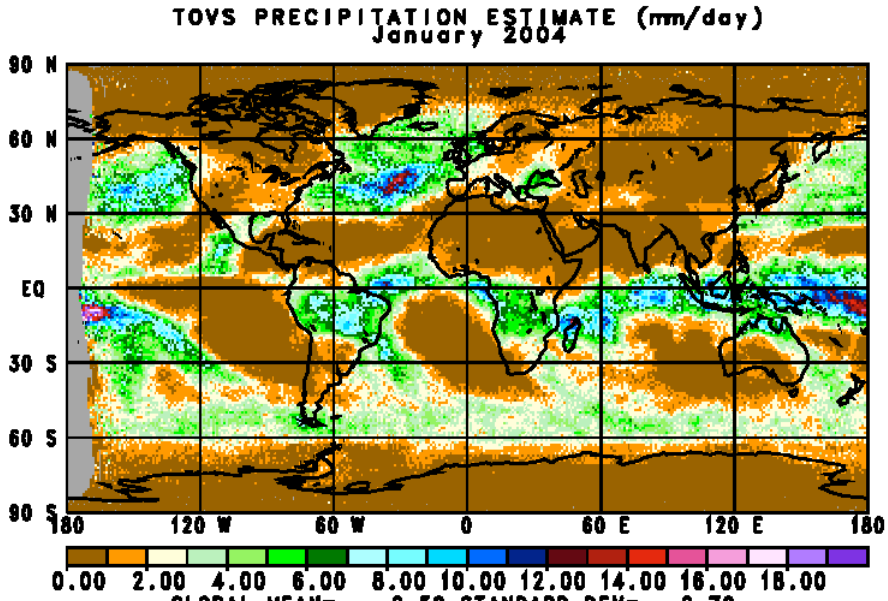
TOVS 7:50 PM minus AIRS 1:30 PM

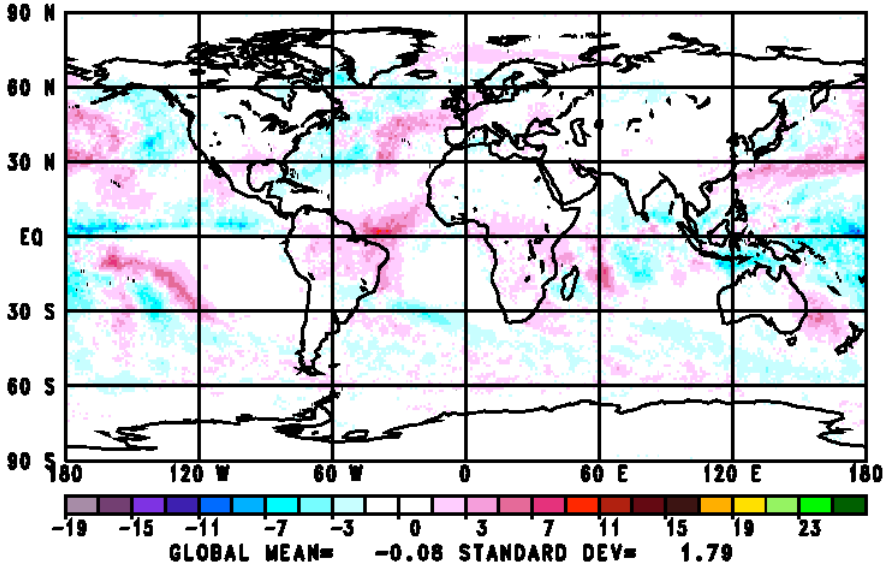


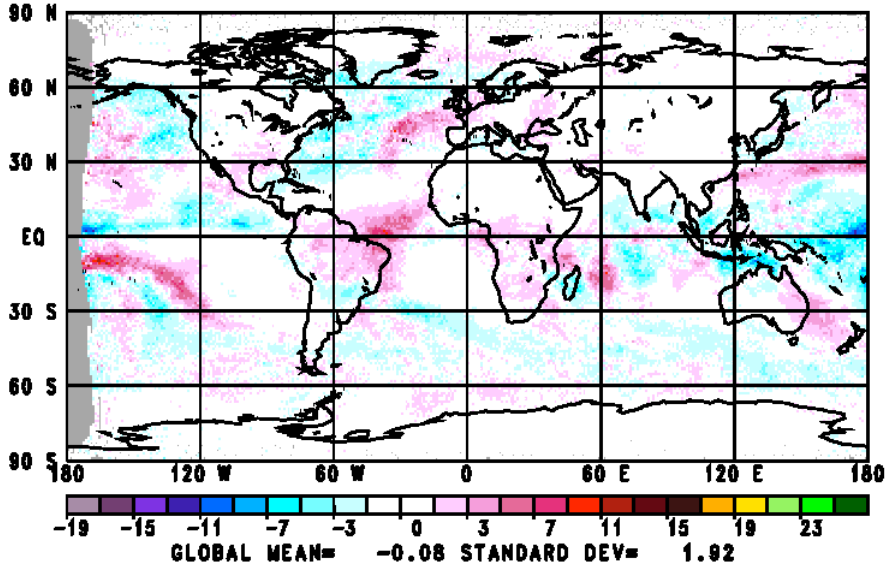
GLOBAL MEAN= 0.07 STANDARD DEV= 4.55 CORRELATION= 0.60

PRECIPITATION ESTIMATE (mm/day)









OLR, CLEAR SKY OLR

OLR trends are a significant indicator of climate change

Wielicki showed TOVS Pathfinder OLR trends agree reasonably well with ERBE, CERES

Science, **295**, 841-844, 2002

Wielicki recently recalibrated ERBE, CERES OLR and found closer agreement with TOVS

TOVS OLR computed from T_s, T(p), q(p), $\alpha\varepsilon$, P_c

JGR, **104**, 12193-12212 (1999)

Explains temporal and spatial variability of OLR in terms of component parts

COMPUTATION OF OLR

TOVS

$$OLR = F\sum_{i=1}^{14}\left[(1-\alpha\varepsilon)F_i^{CLR} + \alpha\varepsilon F_i^{CLD}\right]$$

F_i is a simple channel radiative transfer calculation (RTA) parameterized for 14 channels

Has variable T(p), q(p), O_3(p)

Fixed CO_2 at an old value (350 ppm)

Uses retrieved T_s, T(p), q(p), O_3(p) or forecast value if retrieval is rejected

Uses appropriate $\alpha\varepsilon$, P_c

AIRS

Now done analogously, but uses two values of $\alpha\varepsilon$, P_c for up to 2 cloud levels

Uses coupled IR/MW state or microwave only state as appropriate

Uses identical algorithm to compute F_i

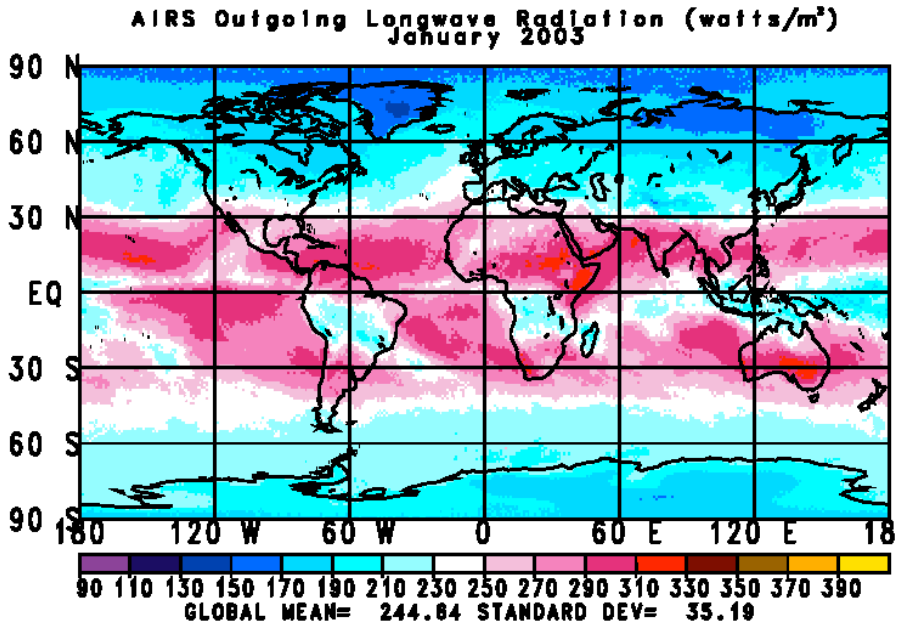
Ways to improve AIRS OLR

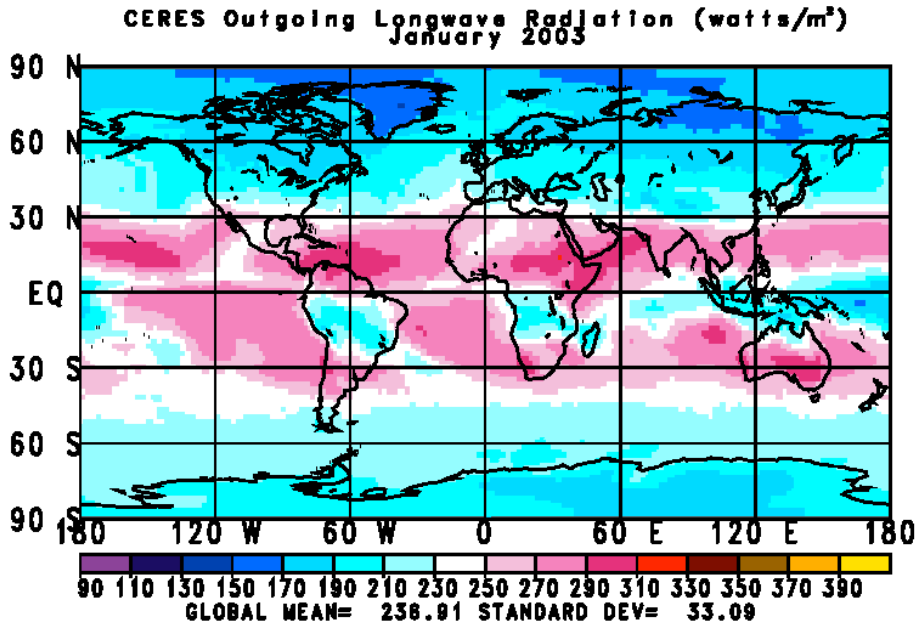
1) Use new RTA for same 14 channels, but latest physics (Larrabee Strow)

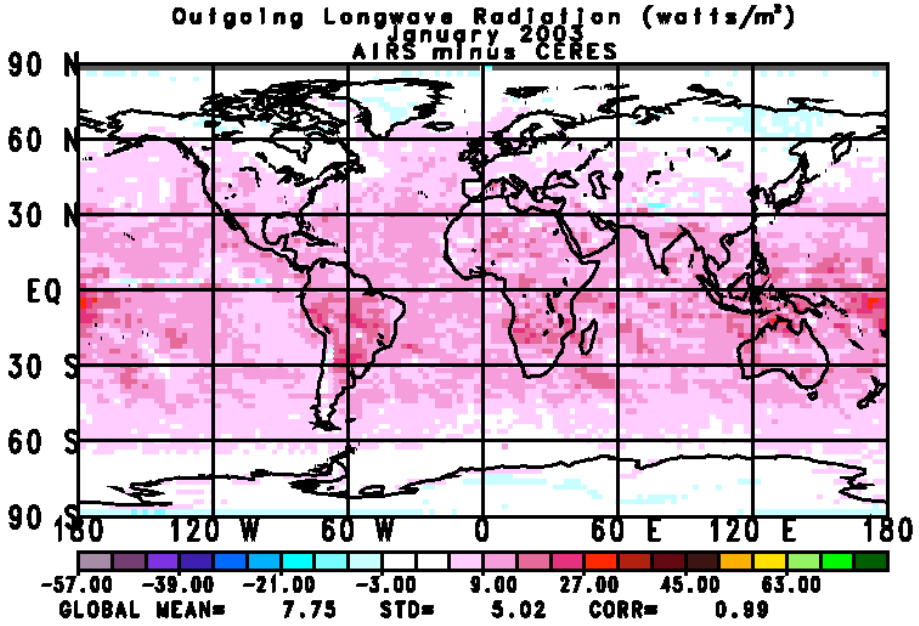
Should allow for variable CO_2 (at least as a function of season, year)

2) More difficult - have $\alpha\varepsilon_i$ where emissivity is a function of frequency ν_i

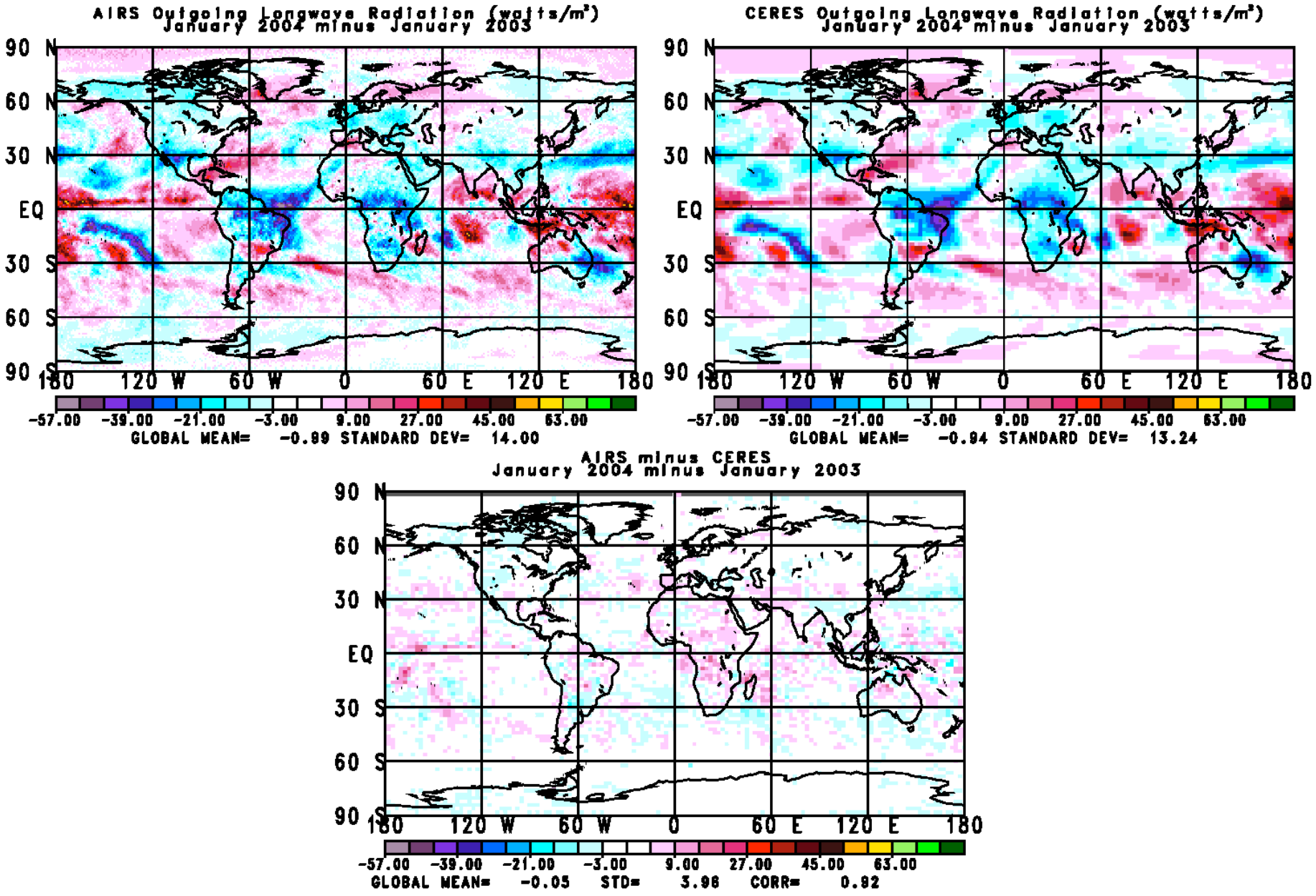
Outgoing Longwave Radiation (watts/m²)





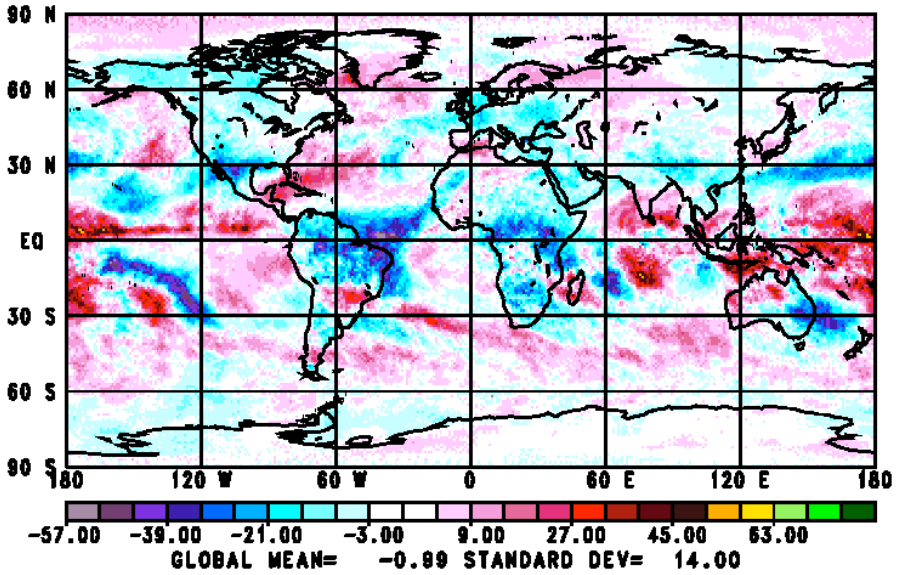


Outgoing Longwave Radiation (watts/m²)



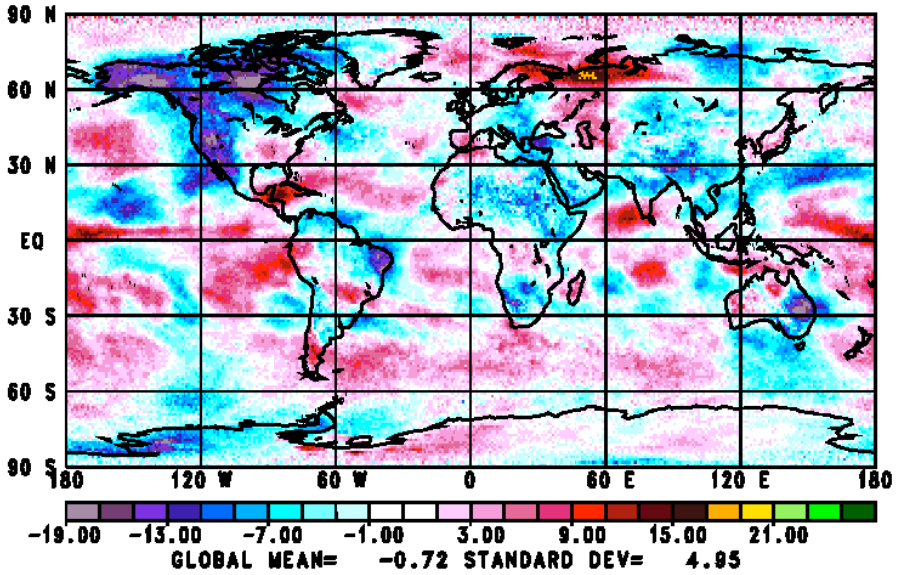
Interannual Differences
January 2004 minus January 2003

AIRS Outgoing Longwave Radiation (watts/m²)



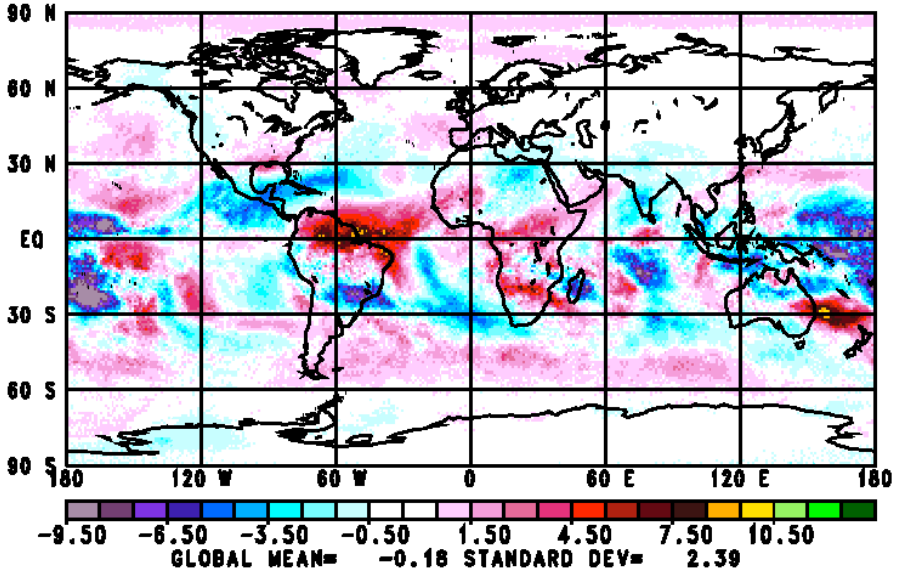
GLOBAL MEAN= -0.99 STANDARD DEV= 14.00

AIRS Clear Sky Outgoing Longwave Radiation (watts/m²)



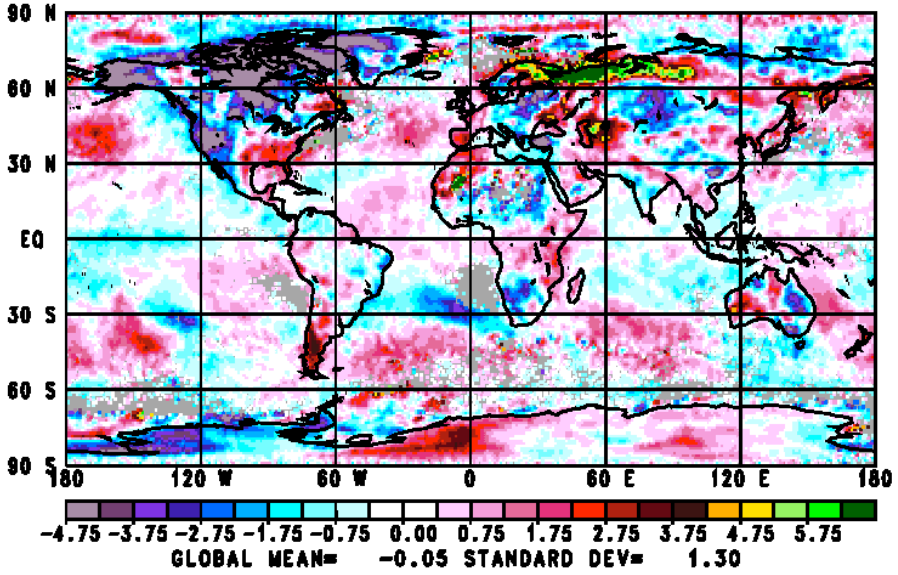
GLOBAL MEAN= -0.72 STANDARD DEV= 4.95

Precipitable Water Above 300 mb (mm*100)



GLOBAL MEAN= -0.18 STANDARD DEV= 2.39

Surface Skin Temperature (K)



GLOBAL MEAN= -0.05 STANDARD DEV= 1.30

VERSION 5.0

MSU2R, MSU4 should be computed sounding by sounding - adds 2 words

New subroutine-computed from final state

Precipitation estimate

Should be computed sounding by sounding - adds 1 word

New subroutine - computed from final state

OLR (Desired)

An improved OLR RTA with variable CO_2

Near term - 4.0

MSU2R, MSU4 can be computed based on Level 3 data, daily or monthly

DAAC?, GSFC?

Precipitation estimate can be computed post processing spot by spot

Requires reading Standard Product and Support Product

I/O intensive

DAAC data mining capability may be a possibility

OLR - nothing can be done without new OLR RTA